Appendix B

Air Quality Monitoring Report

EVERSOURCE
ENERGY

780 North Commercial Street
Manchester, NH 03101

William H. Smagula
Vice President, NH Generation

D33693

October 6, 2016

Mr. Craig A. Wright, Director
NH Department of Environmental Services
Air Resources Division
29 Hazen Drive, PO Box 95
Concord, NH 03302-0092

Re: Public Service Company of New Hampshire d/b/a Eversource Energy Schiller Station, Portsmouth NH – Revised Air Quality Modeling Report Supporting Response to Order – Title V Petition VI-2014-04 and Data Requirements Rule for 2010 1-hour SO2 National Ambient Air Quality Standard

Dear Mr. Wright:

Eversource submits the enclosed revised Air Quality Modeling Report for Schiller Station. The Schiller modeling was conducted to support the NHDES' Response to Order Title V Petition VI-2014-04 regarding the issuance of the Schiller Station Title V Permit TV-0053. The original Air Quality Modeling Report was submitted to NHDES on June 17, 2016. The air quality modeling was revised in response to comments received from the NHDES and USEPA and resubmitted on September 14, 2016. This October 6, 2016 submission includes additional revisions as a result of final comments from NHDES and USEPA. The modeling also addresses the 2010 1-hour NAAQS SO_2 Data Requirement Rule (DRR) and establishes the area attainment designation in the vicinity of Schiller and Newington Stations with respect to the 1-hour NAAQS for SO_2.

The refined air quality modeling was conducted in accordance with the NHDES and USEPA approved Air Quality Modeling Protocol prepared by Exponent, Inc. and dated March 21, 2016. The ADJ_U* beta adjusted surface friction velocity modeling technique was used for the air quality model compliance demonstration as approved by NHDES, USEPA Region 1 and USEPA Model Clearinghouse. Both the modeling protocol and the use of adjusted ADJ_U* modeling option were approved by USEPA in letter to NHDES dated May 2, 2016.

Modeling Revisions

The following revisions were made to the air quality model parameters since the June 17, 2016 submission. Additional details and results related to the revisions presented below are provided in the enclosed revised Air Quality Modeling Report.

- Since Unit 5 was modeled assuming coal combustion to demonstrate the maximum potential emission rate, the modeled exhaust flow rate was revised to correspond to exhaust flow rates expected to be observed during coal combustion. The most recent ARD-2 form submitted to NHDES for Unit 5 is dated October 2013 and included stack flow parameters for biomass only. Page 2 of the ARD-2 form for Unit 5 was revised to include stack flow parameters for both biomass and coal and is provided as an attachment.

- The Newington Station roof height was updated to account for an additional building tier.

- The dimensions of the Schiller Station warehouse building near the Gosling Road entrance were updated consistent with current site drawings.

- Newington Station results are now explicitly reported as a source group.

- The modeling boundary was adjusted on the southeast portion of the Schiller Station property near Porpoise Way to align with the fenceline located perpendicular to the B&M Railroad and the shoreline. Additional receptors were modeled as a result. A revised Site Plan is included as an attachment.

- More detailed modeling boundary descriptions were included in the Air Quality Modeling Report Section 3.3 *Modeling Domain and Receptor Grid* to define the active and passive security measures in place to control access to both Schiller and Newington Stations. The Newington Station modeling boundary was also modified to match the property's northern fenceline and additional receptors were placed on the land between this fence and shoreline. These changes are shown on the attached revised Site Plan.

Modeling Summary

The sources and limits that were modeled and demonstrated compliance with the 1-hour SO2 NAAQS for both the Title V and DRR analysis are represented in Table 1.

Table 1	
Modeled Source	**Maximum Emission Rate/Fuel Limitation Modeled**
SR4	0.933 lbs SO2/MMBtu (coal or oil) with Dry Sorbent Injection (DSI) Control
SR5	0.12 lbs SO2/MMBtu (coal)
SR6	0.933 lbs SO2/MMBtu (coal or oil) with Dry Sorbent Injection (DSI) Control
NT1	Burn No. 6 fuel oil with maximum of 1.0 % sulfur content [1]
NTAB1 and NTAB2	Burn No. 2 fuel oil with maximum of 0.2 % sulfur content [1]

The Schiller sources were modeled at three load conditions; 50%, 75% and 100%. Concentrations of SO_2 at all receptors for Schiller Station emissions modeled at the required three loads are below the NAAQS value of 75 parts per billion (~ 196 ug/m3) as shown below in Table 2 and Table 3.

Table 2 – Title V Modeling: 5-year Average 4th-High Maximum Daily 1-hour SO2 Predicted Concentrations		
Schiller Station Operating Load	**Total Concentration (ug/m3)**	**NAAQS Standard**
100%	191.8	196.0
75%	174.6	
50%	160.4	
Table 3 – DRR Modeling: 3-year Average 4th-High Maximum Daily 1-hour SO2 Predicted Concentrations		
Schiller Station Operating Load	**Total Concentration (ug/m3)**	**NAAQS Standard**
100%	195.9	196.0
75%	177.0	
50%	162.2	

[1] Newington Station Title V Permit TP-OP-054 currently allows the use of No. 6 fuel oil containing a maximum of 2% sulfur and No. 2 fuel oil containing a maximum of 0.4% sulfur by weight. Eversource will request a modification of TP-OP-054 to limit the maximum sulfur content in No. 6 fuel oil burned in NT1 to 1% and No. 2 fuel oil burned in the Aux Boilers to 0.2% by weight.

Justification for Permit Limit Averaging Time Greater than 1 Hour

The air dispersion modeling and associated analysis has demonstrated that an hourly emission rate of 0.933 lbs SO2/MMBtu for SR4 and SR6 is compliant with the 1-hour SO2 NAAQS standard. However, the USEPA has recognized that units may have infrequent occurrences of hourly emissions above this calculated compliance rate due to the variability of operations; and as such USEPA has provided averaging times longer than 1 hour that still provide compliance with the 1-hour standard and attainment of the 2010 SO2 NAAQS. Schiller Station units 4 and 6 are examples of units that experience hourly operational variability in fuel sulfur content and unit load conditions. In addition, SR4 and SR6 each operate a dry sorbent injection (DSI) system for acid gas control, of which SO2 is a component.

Actual historical data from Schiller Station is not available to justify the need for a longer-term average since the facility was only required to operate the Dry Sorbent Injection systems for acid gas control beginning on April 16, 2016. The only applicable data would be from the period between April 16, 2016 and June 30, 2016 (most recent published data). The data from this period is preliminary and represents a very limited number of boiler operating hours, i.e., less than 500 hours for SR4 and less than 36 hours for SR6. Of these operating hours, coal was only burned for approximately 48 hours total between SR4 and SR6. This is not representative of the normal range of permitted operations for these units.

Since actual site data is not available and cannot be relied upon to justify the longer-term average, this justification is based on Eversource's operational knowledge and is consistent with the results of EPA's own analysis presented in Appendix D of the USEPA's April 2014 Guidance for 1-Hour SO2 Nonattainment Area SIP Submission (the Guidance). Results presented in Table 1 of Appendix D of the Guidance clearly indicate that emissions variability is expected to be greater for sources with control equipment than for sources with no control equipment. This is evidenced by the lower average adjustment factors for sources with wet or dry scrubbers than for sources with no control equipment, where lower adjustment factors are the result of more variable emissions.

The results of EPA's analysis are supplemented with Eversource's own knowledge of control device operation at Schiller Station. SR4 and 6 are permitted to burn coal with a sulfur content of 1.3 lb/MMBtu, which would produce uncontrolled SO2 emissions equal to 2.6 lb/MMBtu. Since the critical emission rate was determined to be 0.933 lb/mmbtu for these units, operation of the DSI system is required for compliance. For the following reasons, a 1-hour limit is unreasonable and could result in unnecessary permit violations, despite the overall daily SO2 concentrations being low and not causing or contributing to NAAQS violations.

- *Load variability.* Load variations will require adjustments to be made to the DSI system to maintain the same level of SO2 emissions. Load adjustments and control equipment adjustments are not instantaneous and can cause moderate SO2 emissions variability in hourly data.
- *Short-term maintenance.* If a DSI system operational upset occurred (i.e., sorbent product plugging in the injection lances), the hourly SO2 emissions rate could be impacted. This type of maintenance issue is addressed immediately, but does require time to identify and repair the issue, making a 1-hour standard unreasonable.

The USEPA has accommodated this emissions variability by allowing sources to perform an analysis in accordance with Appendix C of the Guidance to develop longer-term average emission limits that are comparably stringent to a 1-hour limit. And while EPA's Appendix D recognizes the use and appropriateness of up to a 30-boiler operating day average, the SO2 emissions from SR4 and 6 are expected to remain stable on a 24-hour basis. As such, Eversource requests that an emission limit to comply with the 1-hour SO2 NAAQS standard be established in accordance with Appendix C on a 24 hour calendar day average basis, to allow sufficient time to perform DSI system maintenance and make control device adjustments in response to hourly operations variability.

Calculation of Averaging Time Adjustment Factor

Appendix C of the Guidance presents example calculations in which the level of the longer term average limit is derived by applying an adjustment factor to the critical emission value, and the adjustment factor is derived from statistical analysis of a set of data that reflect the emissions variability that the controlled source is expected to exhibit. As described in Appendix C, time series of emissions from the source itself are generally the best source of data for determining expected emissions variability, except to the extent that implementation of a control strategy might change the source's expected emissions variability. In these instances, data from other sources of comparable source type, size, operation, fuel, and control type may be useful for these comparisons.

Schiller Station's historical data represents the variability expected from uncontrolled SO2 emissions from Units 4 and 6. Since it is unknown how the dry sorbent injection (DSI) systems, commissioned in the spring of 2016, would affect the future variability of controlled SO2 emissions from Units 4 and 6, data from a representative source (Gallagher Station, ORISPL=1008) was used in Exponent's adjustment factor analysis. Based on publicly available information available from AMPD and the facility's operating permits, Gallagher Station boilers are of comparable type, size, operation, and fuel to Schiller Station's Units 4 and 6. Gallagher is a coal fired plant with similar characteristics to Schiller and, in fact, was the only facility found in the Air Markets Program Database with existing DSI controls and dry bottom wall-fired coal boilers similar to those at Schiller.

Gallagher Station has operated a DSI system for SO2 emissions control since November 2010. The five most recent complete years of data, 2011 through 2015, were used in the calculation of an adjustment factor. The emissions variability in the Gallagher Station data is expected to reflect the prospective degree of variability that Schiller Station Units 4 and 6 will exhibit following the effective date of the Title V Order Permit Revisions.

An adjustment factor of 0.89 was calculated from the ratio of the 99th percentile of the 24-hour and 1-hour emission values from Gallagher Station in accordance with Appendix C. The adjustment factor translates the hourly emission rate to a comparably stringent 24 hour limit. This adjustment factor was multiplied by the SR4 and 6 modeled emission rate of 0.933 lbs SO_2/MMBtu.

As a result, Eversource has determined that 0.83 lbs SO_2/MMBtu, as determined on a 24 hour calendar day average, is an appropriate emission rate for SR4 and SR6. This emission limit accounts for infrequent, isolated occurrences of hourly SO2 emissions greater than the hourly critical emissions rate. These occurrences do not threaten compliance with the NAAQS. In fact, because the 24-hour limit (0.83 lb/MMBtu) was derived to be comparably stringent to the 1-hour critical emission rate (0.933 lb/MMBtu), and emissions are expected to be below the lower 24-hour limit for the majority of the time, the overall impact to SO2 concentrations in the area will be considerably lower than if a 1-hour standard was selected.

Eversource requests that the Division replace the current sulfur dioxide emission standard found in Table 5, Item 6 with the following for Unit 4 and Unit 6.

6.	*Sulfur dioxide Emission Standard* SO_2 emissions from each unit shall be limited to 0.83 lb/MMBtu of heat input based on a 24 hour calendar day average.	SR4 & SR6

As noted in the footnote on page 2, Eversource intends to submit a modification request for the Newington Station Title V permit to limit the maximum sulfur content in No. 6 fuel oil burned in NT1 to 1% and No. 2 fuel oil burned in the Aux Boilers to 0.2% by weight.

Should you have any questions or require additional information regarding this submittal please contact Melissa A. Cole at 634-2335.

I am authorized to make this submission on behalf of the facility for which this submission is made. Based on information and belief formed after reasonable inquiry, I certify that the statements and information in the enclosed documents are to the best of my knowledge and belief true, accurate and complete. I am aware that there are significant penalties for submitting false statements and information or omitting required statements and information, including the possibility of fine or imprisonment.

Sincerely,

EVERSOURCE ENERGY

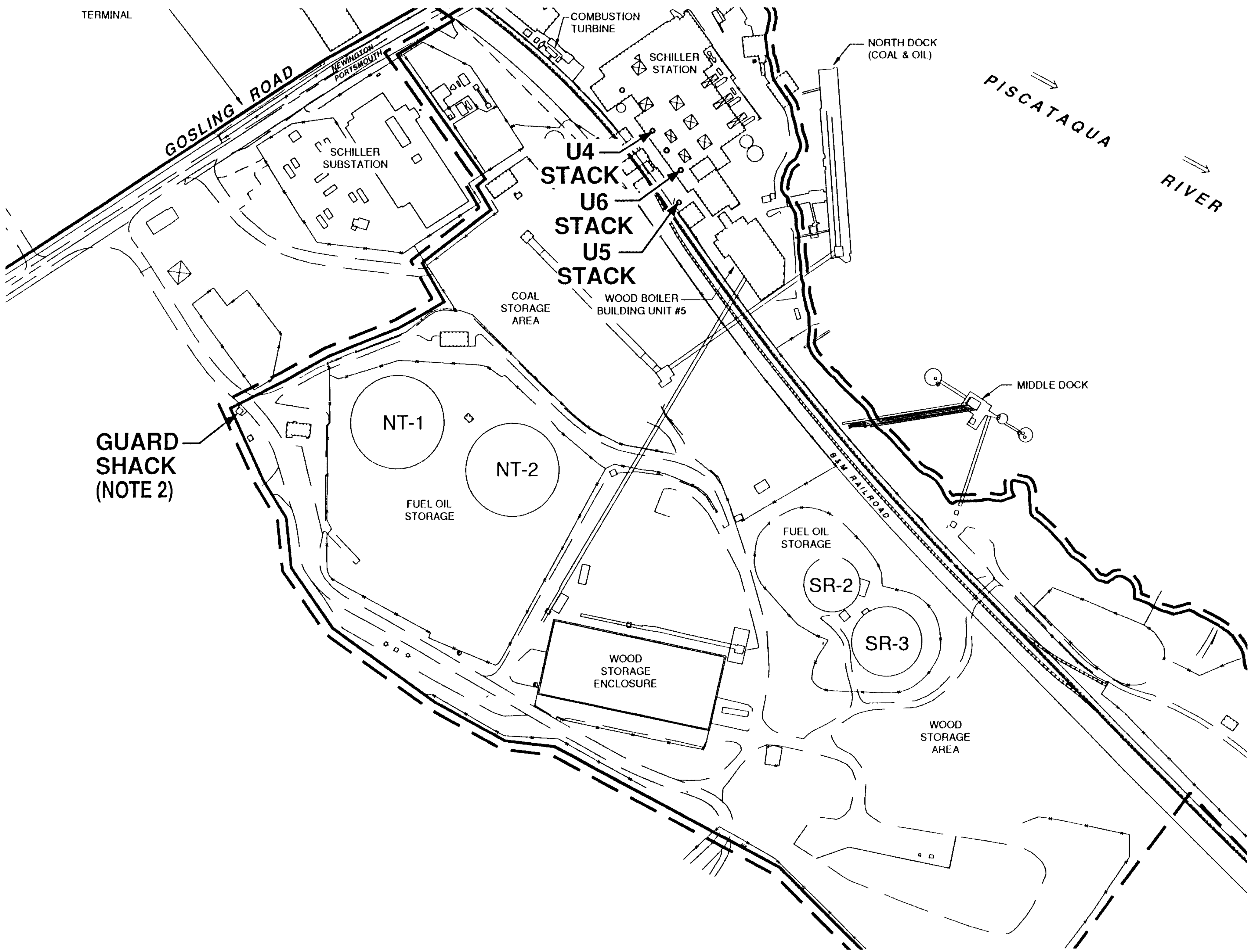
William H. Smagula, P.E.
Vice President – NH Generation

ATTACHMENTS

Revised Site Plan

Revised Excerpt from ARD-2 Form for SR-5

Revised Modeling Report


TERMINAL
GOSLING ROAD
NEWINGTON
PORTSMOUTH
SCHILLER SUBSTATION
COMBUSTION TURBINE
SCHILLER STATION
NORTH DOCK (COAL & OIL)
PISCATAQUA RIVER
U4 STACK
U6 STACK
U5 STACK
WOOD BOILER BUILDING UNIT #5
COAL STORAGE AREA
MIDDLE DOCK
GUARD SHACK (NOTE 2)
NT-1
NT-2
FUEL OIL STORAGE
B&M RAILROAD
FUEL OIL STORAGE
SR-2
SR-3
WOOD STORAGE ENCLOSURE
WOOD STORAGE AREA

Form ARD-2

C. Stack Information

Is unit equipped with multiple stacks? ☐ Yes ☒ No *(if yes, provide data for each stack)*

Identify other devices on this stack: None

Is Section 123 of the Clean Air Act applicable? ☐ Yes ☒ No

Is stack monitoring used? ☒ Yes ☐ No

If yes, Describe: SO2, NOx, CO2, flow, opacity

Is stack capped or otherwise restricted? ☐ Yes ☒ No

If yes, Describe: ____________________

Stack exit orientation: ☒ Vertical ☐ Horizontal ☐ Downward

8.0 ft
Stack ☒ Inside Diameter (ft) ☐ Exit Area (ft^2)

231 ft
Discharge height above ground level (ft)

250,000 (biomass) 215,000 (coal)
Exhaust Flow (acfm)

83 ft/s (biomass) 71 ft/s (coal)
Exhaust Velocity (ft/sec)

325°F (biomass) 275°F (coal)
Exhaust Temperature (°F)

II. OPERATIONAL INFORMATION

A. Fuel Usage Information

1. Fuel Supplier:

Varies
Supplier's Name

Street

Town/City State Zip Code

Telephone Number

2. Fuel Additives:

N/A
Manufacturer's Name

Street

Town/City State Zip Code

Telephone Number

Identification of Additive

Consumption Rate (gallons per 1000 gallons of fuel)

3. Fuel Information *(List each fuel utilized by this device)*:

Type	% Sulfur	% Ash	% Moisture (solid fuels only)	Heat Rating (specify units)	Potential Heat Input (MMBtu/hr)	Actual Annual Usage (specify units)
Biomass	0.01	1-3	50	4,200 btu/lb	720	540,691 tons
Coal	1.9	8	5-8	12,700 btu/lb	635	0 tons

Schiller Station Application Date: September 2011, ARD-2 Form Updated October 2013 with revisions (Pg. 2 only) in August 2016 to update Section C stack information consistent with Title V Order Modeling Parameters. Fuel information as reported in October 2013, with correction to typographical error on Biomass Heat Rate (incorrectly reported as 42,000 btu/lb in 2013).

Exponent®

Atmospheric Sciences

Air Quality Modeling Report for Eversource Energy's Schiller Station

Exponent®

Air Quality Modeling Report for Eversource Energy's Schiller Station

Prepared for

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October 2016

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Contents

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Acronyms and Abbreviations

24/7	24 hours per day, 7 days per week
ASOS	Automated Surface Observing System
BPIPPRM	EPA Building Profile Input Program for PRIME
DEP	Department of Environmental Protection
DRR	Data Requirements Rule
DSI	Dry Sorbent Injection
GEP	Good Engineering Practice
GYX	Gray, Maine
g/s	gram/second
K	degrees Kelvin
km	kilometer
m	meter
m/s	meter per second
$\mu g/m^3$	micrograms per meter cubic
MMBtu	million British thermal units
NAAQS	National Ambient Air Quality Standard
NED	National Elevation Dataset
NHDES	New Hampshire Department of Environmental Services
NO_2	nitrogen dioxide
PSM	Portsmouth International Airport at Pease
ppb	parts per billion by volume
SO_2	sulfur dioxide
TAD	Technical Assistance Document
TPY	tons per year
USEPA	Environmental Protection Agency
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

1 Introduction

Exponent has been retained by Eversource Energy to conduct refined air quality dispersion modeling to address the required Title V permit modeling and to establish the area attainment designation in the vicinity of Schiller Station with respect to the 1-hour National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2).

Guidance used for the modeling was drawn from several Environmental Protection Agency (USEPA) documents, including the following:

- the USEPA *Guideline on Air Quality Models*, codified as Appendix W of 40 CFR Part 51;
- *Area Designations for the 2010 Revised Primary Sulfur Dioxide Ambient Air Quality Standard (*USEPA memorandum, March 24, 2011);
- *Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 NAAQS* (USEPA memorandum, August 23, 2010);
- *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard* (USEPA memorandum, March 1, 2011);
- *SO_2 NAAQS Designations Modeling Technical Assistance Document* (TAD) (USEPA DRAFT document, February 2016);
- Proposed rule: *Revision to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches To Address Ozone and Fine Particulate Matter*, Federal Register 80, 45340-45387, July 29, 2015; and
- *Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard (NAAQS); Final Rule*, Federal Register 80, 162, 51052-51088, August 21, 2015.

The modeling also drew on guidance from the New Hampshire Department of Environmental Services (NHDES) document "Guidance and Procedure for Performing Air Quality Impact Modeling in New Hampshire (July, 2006)."

The most recent version of AERMOD (v15181) was used as the air quality model for the compliance assessment demonstration. The most recent versions of AERSURFACE (v13016), AERMET (v15181), AERMAP (v11103), and BPIPPRM (v04274) were also used for preparing data for AERMOD.

The ADJ_U* beta option in AERMET was used for the air quality modeling demonstration. A separate justification document to use beta option ADJ_U* in AERMET was approved by NHDES, USEPA Region I, and the USEPA Model Clearinghouse (USEPA, 2016a).

In Section 2, descriptions of the modeled source parameters and emissions and building data are provided. A discussion of the meteorological data used in the modeling, a brief description of the dispersion models, the receptor grid, and information on the background concentrations are provided in Section 3. Section 4 presents the predicted modeling results against the relevant air quality standards. Section 5 presents a list of references.

2 Source Inventory

2.1 Source Description

The Schiller Station sources modeled consisted of Unit 4, Unit 5, and Unit 6 and were modeled for each of three loads: 50%, 75% and 100%. The Newington Station sources modeled consist of Unit 1, Auxiliary Boiler A, and Auxiliary Boiler B.

Schiller Station Units 4 and 6 were modeled with 0.933 pounds of SO_2 per million British thermal units (MMBtu) with Dry Sorbent Injection (DSI) control. Schiller Station Unit 5 was modeled firing coal with 0.12 pounds of SO_2 per MMBtu. Newington Station Unit 1 was assumed to fire #6 fuel oil with 1.0% sulfur content, and Auxiliary Boilers A and B were modeled firing #2 fuel oil with 0.2% sulfur content.

The March 1, 2011 EPA additional clarification memorandum guidance states that intermittent sources and intermittent operating scenarios may not need to be modeled for 1-hour SO_2 NAAQS compliance analyses. This is because their operations may not be frequent or continuous enough to contribute significantly to the annual distribution of the daily maximum 1-hour concentrations. Intermittent sources, such as emergency units, are often limited to no more than 500 hours of operation per year and typically operate less frequently and on a random schedule that cannot be controlled. Intermittent operating scenarios, such as startup and shutdown, may similarly be exempted from modeling for the 1-hour SO_2 NAAQS, particularly in the case of base load facilities like Schiller Station.

At Schiller Station, annual operation during 2012-2014 averaged 10.6 hours for the combustion turbine and 6.7 hours for the emergency generator. At Newington, the emergency generator operated an average of 11.5 hours a year during the same period. These units clearly operate intermittently and qualify for exclusion from the 1-hour NAAQS modeling analysis. Consequently, these intermittent sources were excluded from the modeling analysis.

The modeled source parameters and emission rates are summarized in Table 1.

Table 1. Modeled Point Source Parameters and Emission Rates

Stack ID	Stack Name	UTM-19N [NAD83] East (m)	UTM-19N [NAD83] North (m)	Base Elev. (m)	Stack Ht. (m)	Exit Temp. (K)	Exit Veloc. (m/s)	Stack Diam. (m)	SO_2 (g/s)
SR4 (100% Load)	Unit 4	354819.20	4773182.97	7.3	68.9	450	22.86	2.44	67.5
SR5 (100% Load)	Unit 5	354832.59	4773134.78	6.4	70.4	431	21.70	2.44	9.6
SR6 (100% Load)	Unit 6	354838.68	4773154.22	7.3	68.9	450	22.86	2.44	67.5
SR4 (75% Load)	Unit 4	354819.20	4773182.97	7.3	68.9	450	17.15	2.44	50.6
SR5 (75% Load)	Unit 5	354832.59	4773134.78	6.4	70.4	431	16.28	2.44	7.2
SR6 (75% Load)	Unit 6	354838.68	4773154.22	7.3	68.9	450	17.15	2.44	50.6
SR4 (50% Load)	Unit 4	354819.20	4773182.97	7.3	68.9	450	11.43	2.44	33.8
SR5 (50% Load)	Unit 5	354832.59	4773134.78	6.4	70.4	431	10.85	2.44	4.8
SR6 (50% Load)	Unit 6	354838.68	4773154.22	7.3	68.9	450	11.43	2.44	33.8
NT1	Unit 1	354282.75	4773491.96	8.2	125.0	533	25.75	6.32	574.2
NTAuxA	Auxiliary Boiler A	354259.48	4773424.76	8.2	59.4	578	21.65	1.07	2.5
NTAuxB	Auxiliary Boiler B	354231.49	4773444.46	8.2	59.4	578	21.65	1.07	2.5

2.2 Building Downwash Analysis

Plumes from short stacks that are relatively close to buildings or other structures can be affected by the wake from those structures. This effect, which reduces plume rise and enhances plume dispersion, is called building downwash.

AERMOD has algorithms to simulate building downwash. The building parameters used by AERMOD are calculated using the EPA Building Profile Input Program for PRIME (BPIPPRM, dated 04274). The program incorporates Good Engineering Practice (GEP) guidance and building downwash guidance to identify the building heights and projected building widths that affect the dispersion of pollutants from the source in question.

For every wind direction, the area of influence extends five times L (5L) directly downwind from the trailing edge of the structure, where L is the lesser of the building's height or direction-specific projected building width. The area of influence extends 0.5L in the crosswind direction and 2L in the upwind direction. A building's wake effect height is determined by adding 1.5L to the building's height. The building with the largest wake effect height, whose area of influence encompasses a stack, is the dominant influential building for that stack. Wakes from two structures that are closer than the greater of either structure's L are considered "sufficiently close" to one another that their wakes effectively act as one. If the projected widths of the structures do not overlap, then the structures are combined and the gap between the two structures is treated as if the gap had been filled with a structure equal in height to the lower structure.

A complete building downwash analysis was conducted to develop the building parameters needed for AERMOD.

Figure 1 shows a plot of the buildings and stacks. Figure 2 shows the building dimensions used in BPIPPRM superimposed on a Google Earth image of the site.

Figure 1. Plot of Schiller and Newington Station buildings and stacks

Figure 2. Plot of Schiller and Newington Station buildings and stacks over a Google Earth aerial photograph

3 Methodology

3.1 Meteorological Data

The most recent five years of hourly surface meteorological data (2010-2014) from the Portsmouth International Airport at Pease (PSM), which is only about 3 kilometers (km) from Schiller Station, were used for the Title V air quality simulations. This is the most representative source of surface meteorological data for the modeling domain. Concurrent twice-daily rawinsonde observations from Gray, Maine (GYX) were used as the source of upper air data.

The first step in the meteorological data processing was to determine the roughness length, albedo, and Bowen ratio for the location of the surface meteorological data. This was done on a seasonal basis by applying the EPA AERSURFACE model (v13016) using land cover categories from the U.S. Geological Survey (USGS) from 1992. The seasons were defined as:

- December – March (winter with snow on the ground),
- April – May (transitional spring),
- June – August (midsummer with lush vegetation),
- September – October (autumn with unharvested cropland), and
- November (late autumn after frost and harvest or winter with no snow).

The 1 km default radius around the meteorological tower was used for land cover and was divided into twelve, 30-degree sectors. The surface moisture condition, which is required for the Bowen ratio, was determined by comparing precipitation records at Eliot, Maine obtained from the U.S. National Climatic Data Center. Eliot is the nearest hydrologic station to Schiller Station with long-term, monthly precipitation observations. As suggested in the AERSURFACE User's Guide, the annual precipitation for each of the years 2010-2014 was compared against the 30-year climatological record from 1985-2014. Because precipitation for the years 2010 and 2011 was in the upper 30th percentile, the moisture condition was set to "wet" in AERSURFACE for these years. For 2012 and 2014, the precipitation was between the 30th and 70th percentile so the moisture condition was "average". For 2013, the precipitation was in the lower 30th percentile so the moisture condition was "dry".

The meteorological data were processed using AERMET (v15181). PSM is not an Automated Surface Observing System (ASOS) site. Therefore, AERMINUTE was not applied. Even so, fewer than 10% of the winds were reported as calm. A plot of the five-year wind rose is shown in Figure 3.

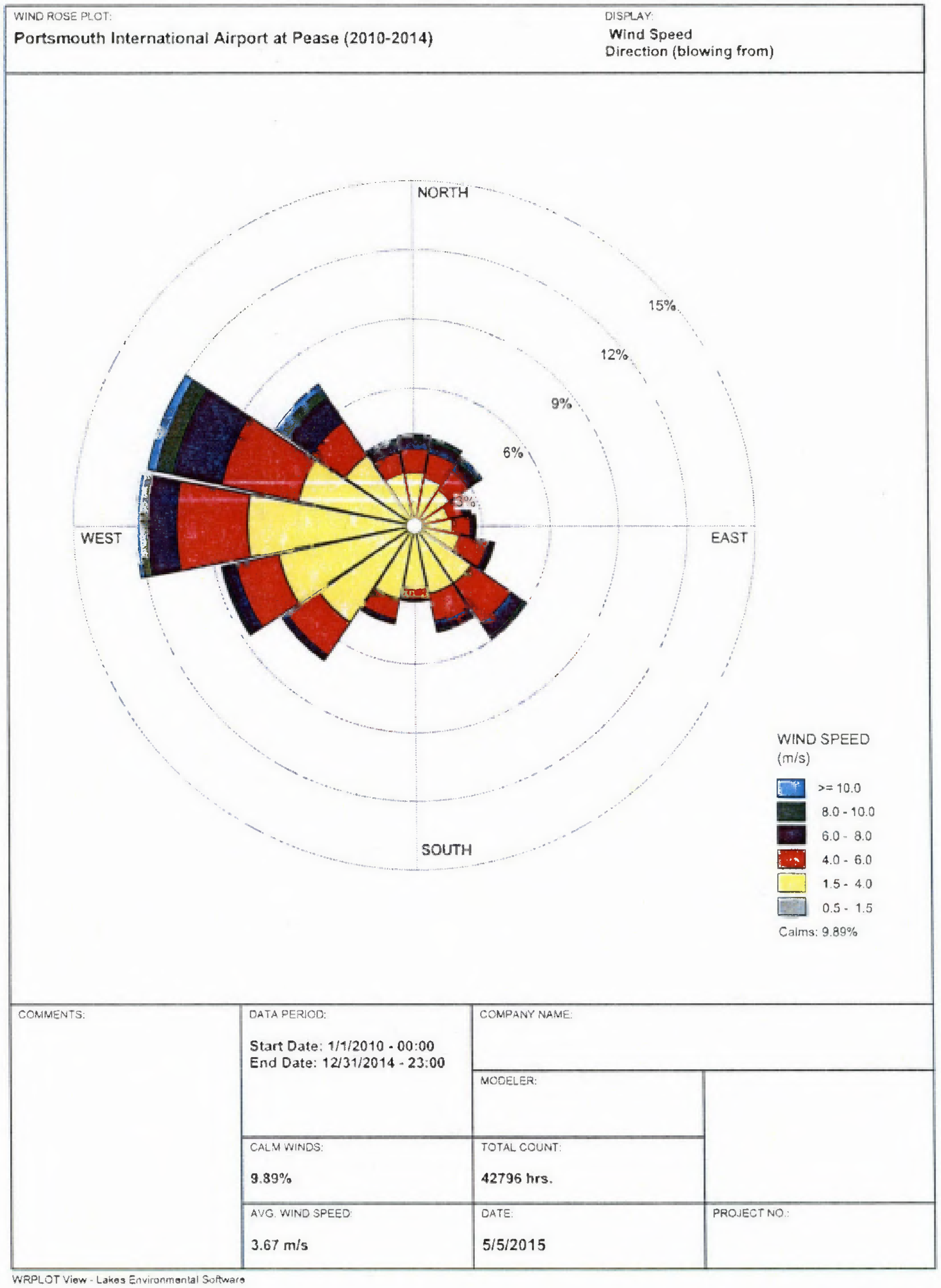

Figure 3. Wind rose for surface observations at Portsmouth International Airport (2010-2014)

3.2 AERMOD

The AERMOD modeling system (*US EPA, 2004*) is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of surface and elevated sources. EPA's "Guideline on Air Quality Models" (*EPA, 2005*) identifies AERMOD as the preferred refined dispersion modeling technique for simple and complex terrain for receptors within 50 km of a modeled source.

The latest version of AERMET (v15181) was used to generate the meteorological dataset for input into AERMOD. The beta option ADJ_U* in AERMET was used per approval by NHDES, EPA Region I, and the EPA Model Clearinghouse (EPA, 2016a). This option is intended to provide correction to acknowledged over-prediction by AERMOD during low wind speed, stable conditions. At the 11^{th} Modeling Conference, EPA stated its intent to incorporate beta option ADJ_U* in AERMET into the regulatory versions of the models (EPA, 2015b), and EPA has proposed to make ADJ_U* a regulatory default option as part of the proposed rulemaking to revise the modeling guideline.

The latest version of AERMOD (v15181) was used to conduct the modeling to address the required Title V permit modeling and to establish the area attainment designation in the vicinity of Schiller Station with respect to the 1-hour NAAQS for SO_2.

3.3 Modeling Domain and Receptor Grid

A modeling domain extending 50 km from a point located halfway between Schiller Station and Newington Station (the "midpoint") was used in this modeling assessment. The center of the modeling domain is defined by the average of (1) Newington Unit 1 stack coordinates and (2) the average of Schiller Unit 4 and Unit 6 stack coordinates. This is consistent with the March 24, 2011 memorandum that suggests centering the domain on the dominant source or a violating monitor. In this case, the modeling is intended to assess compliance with the NAAQS in an area in which Schiller Station and Newington Station are the dominant SO_2 emission sources and where the separation of the two stations is small in comparison to the modeling domain.

The receptor grid is composed of (1) fence line receptors around each station, (2) two Cartesian grids covering an area of 5 km by 5 km centered on the midpoint, (3) a polar grid centered on the midpoint and extending out to 50 km, and (4) Cartesian grids covering an area of 1 km by 1 km centered on the areas outside the two main Cartesian grids that are expected to have the highest impacts.

The security program at Schiller Station operates 24 hours per day, 7 days per week (24/7) and is designed to prevent unknowing or unauthorized entry of persons to the facility. Entry control measures include security guard monitoring and patrol, video monitoring, property line perimeter fencing and controlled access warning signs. There are two security guard stations, one at the entrance to the station and the other at the entrance to the fuel and wood storage areas. Both are manned 24/7 by contracted professional security guards.

The security program at Newington Station operates 24/7 and is designed to prevent unknowing or unauthorized entry of persons to the facility. Entry control measures include security guard monitoring, video monitoring, property line perimeter fencing and controlled access warning signs. All visitors and contractors enter via the security guard station and all employees enter via a separate employee gate. Both locations are secured with locked gates and 24/7 monitored video cameras. Three additional video cameras are located across the property, including one located on the rooftop of the screen house providing surveillance of the shore front. All video cameras are monitored in the control room 24/7. As an additional operational and security measure, the operations department also performs rounds across the facility twice per shift (i.e. four times per day).

Fence line receptors were placed along the plant boundaries at both stations with a spacing of no more than 20 meters (m). This interval is consistent with NHDES guidance provided in the "Guidance and Procedure for Performing Air Quality Impact Modeling in New Hampshire (July, 2006)." The property contained within these fence line receptors is inaccessible to the public. There were 110 fence line receptors selected to encompass Newington Station and 163 fence line receptors selected to encompass Schiller Station.

The Cartesian grid is centered on the midpoint (354555.85m UTM-E, 4773330.28m UTM-N), where the coordinates are in UTM (Universal Transverse Mercator), Datum NAD83, Zone 19. The inner Cartesian grid extends 1500m from the midpoint with an interval of 50m. An outer Cartesian grid extends 2500m from the midpoint with an interval of 100m. The Cartesian grids contain 5,227 receptors.

The polar receptor grid is centered on the midpoint and extends out 50 km. The polar grid contains 36 radials at 10 degree intervals. The ring distances of the polar grid were selected at:

- 250m intervals from 2,500m to 10,000m; and
- 500m intervals from 10,000m to 50,000m.

Receptors within the area covered by the Cartesian grids were excluded, leading to 3,929 polar grid receptors.

Twenty additional discrete receptors were added to the grid. These included the following 3 monitor locations: (1) the Peirce Island monitor (357695, 4770667)[1], (2) the Sawgrass monitor (356007, 4774707), and (3) the Eliot monitor deployed on Alden Lane for the NHDES 1999 sulfur dioxide study (355354, 4773158). In addition, 17 other receptors were added at the request of NHDES. Seven of these receptors were designed to capture the following predicted 1-hour impacts (1) the maximum concentration (355700, 4774000), (2) the secondary maximum concentration (355300, 4781700), (3) the 4th high maximum concentration (355400, 4773100), (4) the maximum predicted impact in Maine, located near Mount Agamenticus (362800, 4787200), (5) a local maximum in Eliot (356500, 4774200), (6) a second local maximum in Eliot (357500, 4774000), and (7) a local maximum in New Hampshire (355000, 4772500). The remaining 10 receptors were locations of the highest 1-hour concentrations in modeling conducted by the Sierra Club: (362777, 4786803), (362527, 4786370), (363027, 4787236), (363277, 4787669), (354344, 4773197), (354307, 4773118), (355643, 4772447), (355543, 4773589), (354285, 4773033), and (354394, 4772625). Cartesian grids of receptors covering an area of at least 1 km by 1 km with 100m spacing were centered on these twenty additional discrete receptors. Receptors already within the area covered by the two main 5 km by 5 km Cartesian grids were excluded, leading to 860 additional gridded receptors with 100m resolution.

The resulting total number of receptors is 10,309, consisting of the 273 fence line receptors, the 6,087 Cartesian receptors, the 3,929 polar grid receptors and the 20 discrete receptors.

Terrain elevations were obtained from the 10-meter National Elevation Dataset (NED) that is made available by the U.S. Geological Survey (USGS). The data were processed using AERMAP (version 11103). A plot of the full receptor grid superimposed on terrain elevations is shown in Figure 4. Figure 5 shows a zoomed-in version of the fence line and near-field Cartesian receptors. Figure 6 shows in orange the additional 1 km by 1 km with 100m spacing Cartesian gridded receptors centered on the twenty additional discrete receptors, shown in blue, with the two main 5 km by 5 km Cartesian grids shown in grey.

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[1] Coordinates are in Universal Transverse Mercator (UTM), North American Datum 1983, zone 19, in units of meters.

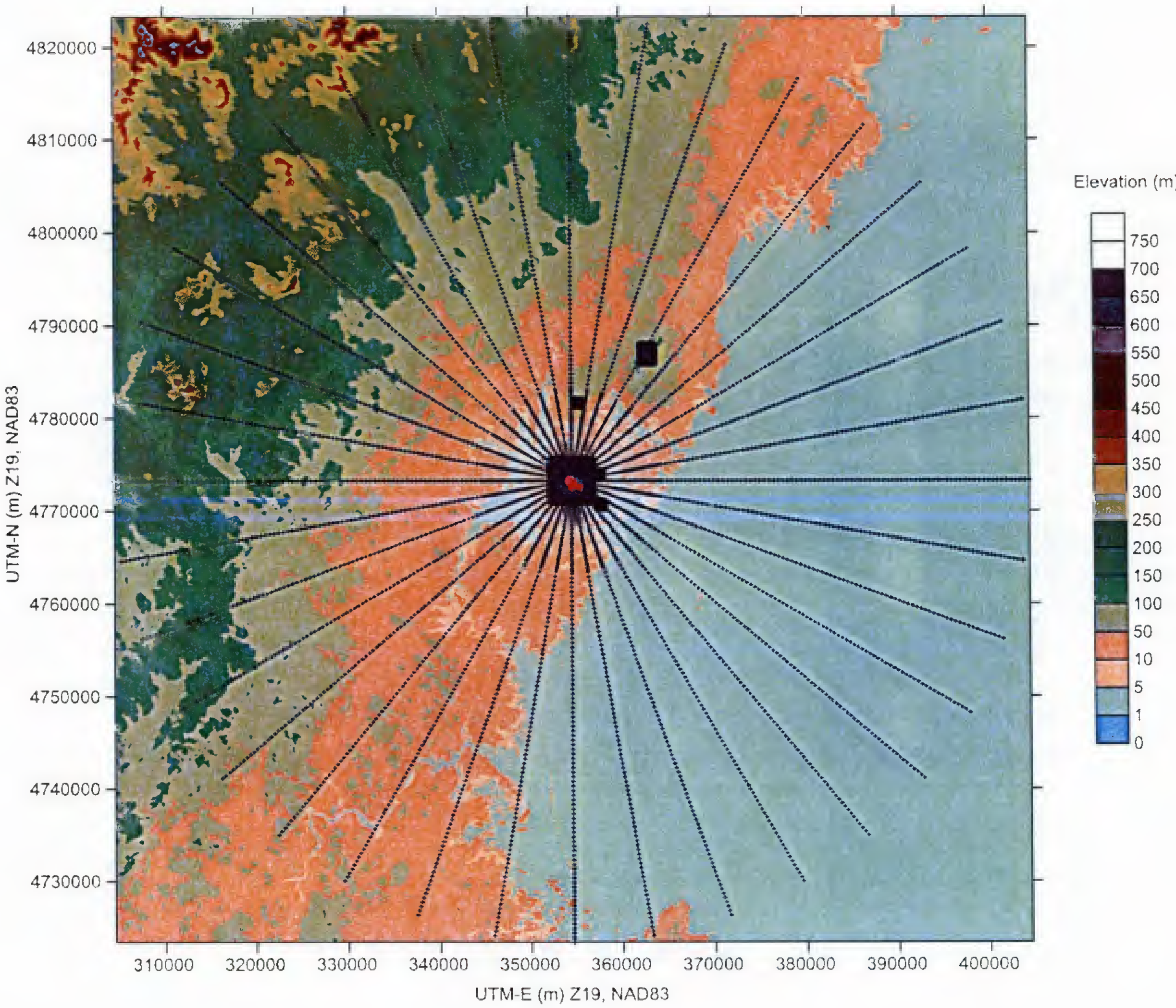

Figure 4. All receptors plotted on topography

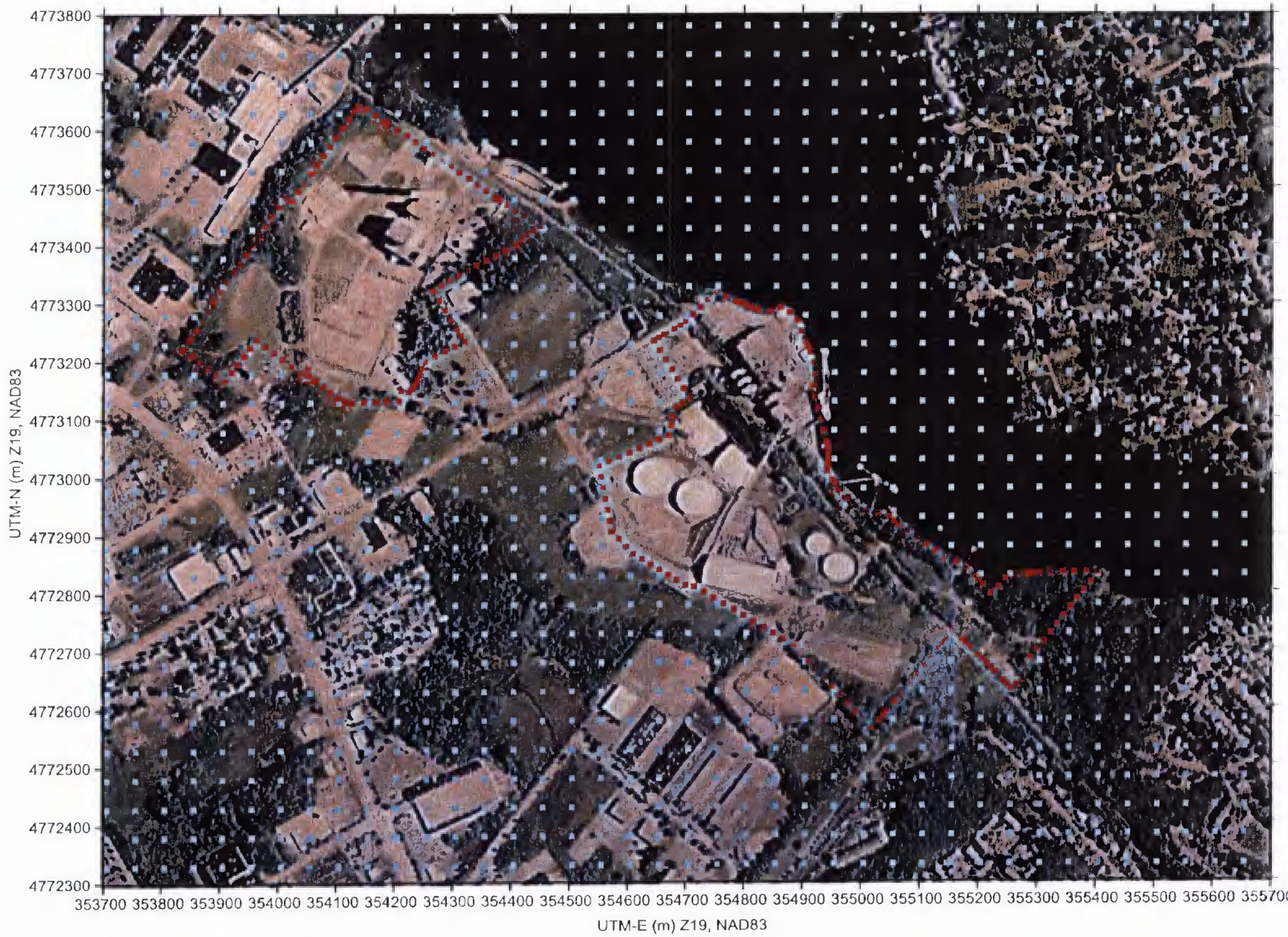

Figure 5. Fenceline and near-field Cartesian receptors

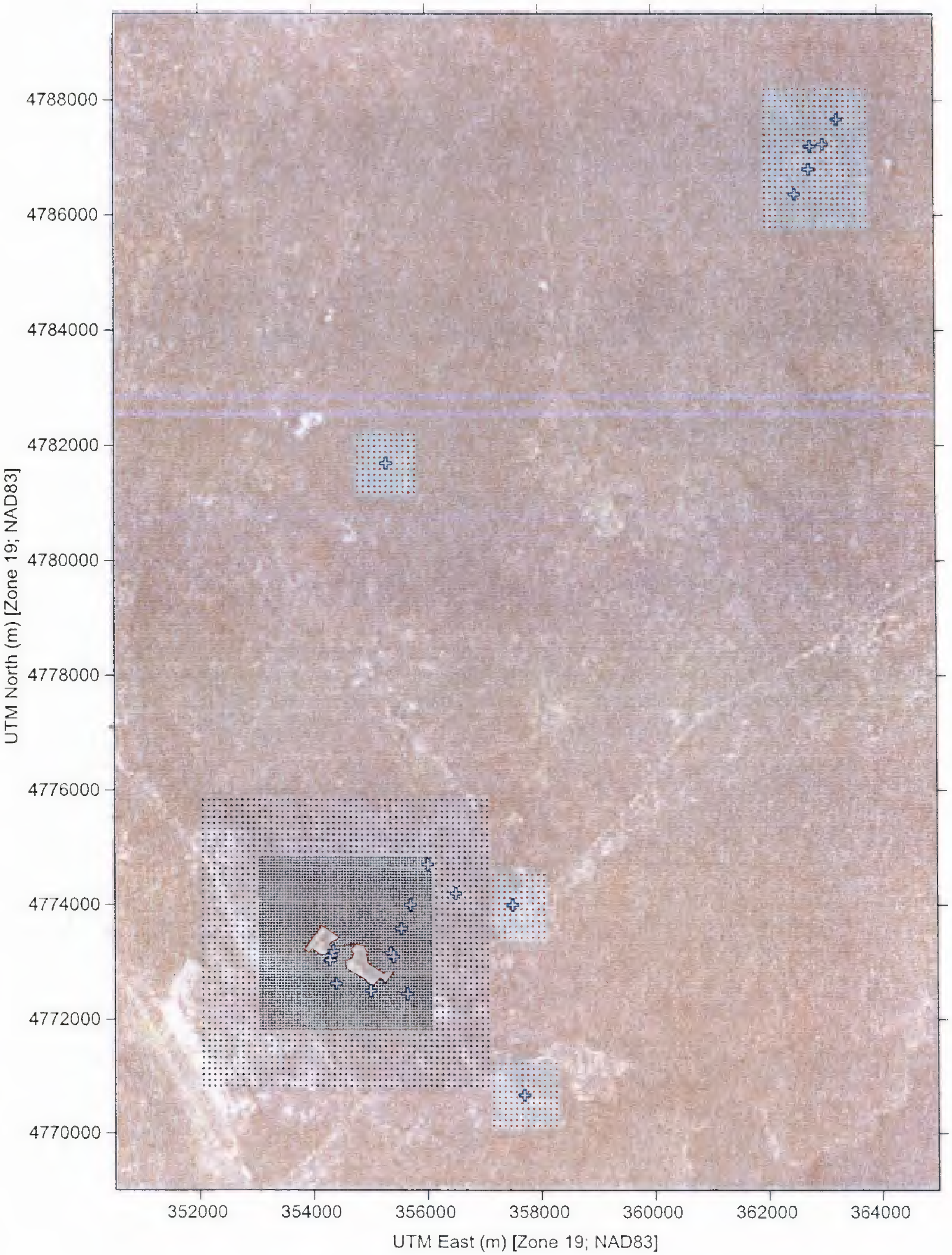

Figure 6. Cartesian gridded receptors

3.4 Modeled Background Sources

The EPA March 1, 2011 additional clarification memo states "emphasis on determining which nearby sources to include in the modeling analysis should focus on the area within about 10 km of the project location in most cases. The routine inclusion of all sources within 50 km of the project location, the nominal distance for which AERMOD is applicable, is likely to produce an overly conservative result in most cases."

For this modeling demonstration, NHDES provided a list of potential interactive SO_2 sources within 50 km of Schiller Station with actual SO_2 emissions for 2011-2014 that exceeded 5 tons per year (TPY). These sources, in addition to Newington Station, are National Gypsum, Essential Power Newington, Turnkey Recycling, and the University of New Hampshire. Based on data from 2012 for permitted sources in New Hampshire, more than 95% of the actual SO_2 emissions are produced by sources whose actual SO_2 emissions exceed 5 TPY.

NHDES requested lists of potential interactive SO_2 sources from the Maine Department of Environmental Protection (DEP) and the Massachusetts DEP. Maine DEP identified only the Portsmouth Naval Shipyard in Kittery as a potential interactive source for SO_2. Massachusetts DEP identified only Wheelabrator North Andover in North Andover as a potential interactive source for SO_2.

The most recent emission inventory data publicly available from Maine DEP show that the actual SO_2 emissions from the Portsmouth Naval Shipyard were only 0.21 tons in 2011 and 2012, 0.18 tons in 2013 and 0.24 tons in 2014. Since these are well below the 5 TPY threshold used by NHDES, this source was not included in the 1-hour SO_2 NAAQS modeling analysis.

The most recent emission inventory data publicly available from EPA show that the actual SO_2 emissions from Wheelabrator North Andover were 38.4 tons in 2011, 47.0 tons in 2012, 57.1 tons in 2013, and 40.8 tons in 2014. Although the facility is nearly 50 km from Schiller Station, it was included as a background source with annual SO_2 emissions of 57.1 tons.

NHDES provided actual monthly SO_2 emissions for the period 2011-2014 and associated stack parameters for each non-emergency source at National Gypsum, Essential Power Newington, Turnkey Recycling, and the University of New Hampshire. These four interactive facilities in New Hampshire were included in the 1-hour SO_2 NAAQS modeling analysis along with Schiller Station and Newington Station. As described below, conservative estimates of actual emissions in the Title V modeling for these sources were incorporated through use of the "EMISFACT MONTH" keywords in AERMOD.

For each of these four facilities, the actual SO_2 emissions in each month in the period 2011-2014 (as provided by NHDES) were reviewed for each stack serving a non-emergency source. For each such stack, the maximum actual emissions in a particular month over the four years of data (e.g., the maximum January emissions) were determined and then apportioned equally over the month assuming continuous operation. So, for example, the maximum January emissions for a stack was modeled for all years using emissions based on the year in the period with the maximum January emissions for that stack. The use of actual, as opposed to allowable, emissions for these four sources accounts for the manner in which they typically operate. The use of maximum monthly actual emissions accounts for the highest monthly values over a four year period. Many sources in New Hampshire are allowed to operate using a variety of fuels but, in recent years, have operated using low sulfur fuels, such as natural gas or ultra-low sulfur oil.

3.5 Ambient Background Concentration

As described in more detail below, 1-hour SO_2 background concentrations for the study area were established based on monitoring data collected from monitors at Peirce Island and Londonderry. Consistent with guidance in the March 1, 2011 EPA additional clarification memorandum, 1-hour SO_2 background concentrations were defined as a function of season and hour-of-day, excluding periods when the source in question was expected to impact the monitored concentration.

The closest SO_2 air quality monitor to the study area is the Peirce Island monitor, which is located approximately 4 km southeast of Schiller and Newington Stations. The SO_2 concentrations measured at the Peirce Island monitor are clearly affected by emissions from these two sources. Therefore, another source of air quality data reflecting regional levels was needed to account for background levels during periods when the Peirce Island monitor was likely to be affected by emissions from Schiller Station or Newington Station. The monitor in Londonderry was used for this purpose.

The March 1, 2011 EPA additional clarification memorandum guidance states that an appropriate methodology for incorporating background concentrations in the cumulative impact assessment for the 1-hour SO_2 standard would be to use multiyear averages of the 99^{th} percentile of the available background concentrations by season and hour-of-day, excluding periods when the source in question is expected to impact the monitored concentration. The guidance also states that the second-highest value for each season and hour-of-day combination should be used to estimate the 99^{th} percentile.

The *Guideline on Air Quality Models* (Section 8.2.2), referred to by the March 1, 2011 EPA additional clarification memorandum, outlines an approach to minimize double-counting of contributions to the measured concentrations by sources that will be in the modeled background. The guidance calls for a 90-degree sector downwind of a source to be used to determine the area of impact for that source. In other words, if the wind direction is within 45 degrees of the direction from the modeled source to the monitor, the hour can be excluded from those used to determine ambient background concentrations for the cumulative impact analysis. In this case, a slightly wider overall exclusion sector was needed based on the different locations of Schiller Station and Newington Station relative to the Peirce Island monitor. To account for this, a 92-degree exclusion sector (263° – 355°, inclusive; Figure 7) was used for identifying hours in which the Peirce Island monitor was likely affected by SO_2 emissions from either Schiller Station or Newington Station.

The following procedure was used for defining the 1-hour SO_2 background concentrations for use in the 1-hour SO_2 modeling assessment analysis.

1. Start with the most recent 3-year record (2012-2014) of hourly SO_2 concentrations measured at the Peirce Island and Londonderry air quality monitors.
2. If the SO_2 concentration from Londonderry is missing, interpolate a value for periods of three hours or less.
3. For each hour, examine the associated wind speed and wind direction measured at PSM and at the Peirce Island monitor.

4. Determine if the wind speed and wind direction at each monitor are "valid" (i.e., not missing). Hours with missing wind data at Peirce Island are filled with wind data from PSM.
5. If wind data at both Peirce Island and PSM are invalid, use the hourly SO_2 concentration measured at Londonderry (since there's no way to tell if the SO_2 concentration at Peirce Island may have been affected by emissions from Schiller Station or Newington Station).
6. For hours with valid wind data, if the wind direction is within the defined exclusion sector, then exclude the SO_2 concentration measured at Peirce Island and use the concentration from Londonderry instead.
7. Interpolate a concentration at Peirce Island for missing hours for periods of three hours or less if the hours interpolated between are both valid hours with wind directions outside of the defined exclusion sector.
8. If the wind direction for a valid hour is not within the exclusion sector, use the SO_2 concentration from Peirce Island.

Following this procedure with 2012-2014 monitoring data and wind observations, the hourly background, as a function of season and hour of day, is shown in Table 2. All of the observed concentrations at Peirce Island with wind directions outside the 92-degree exclusion sector were included in the calculations.

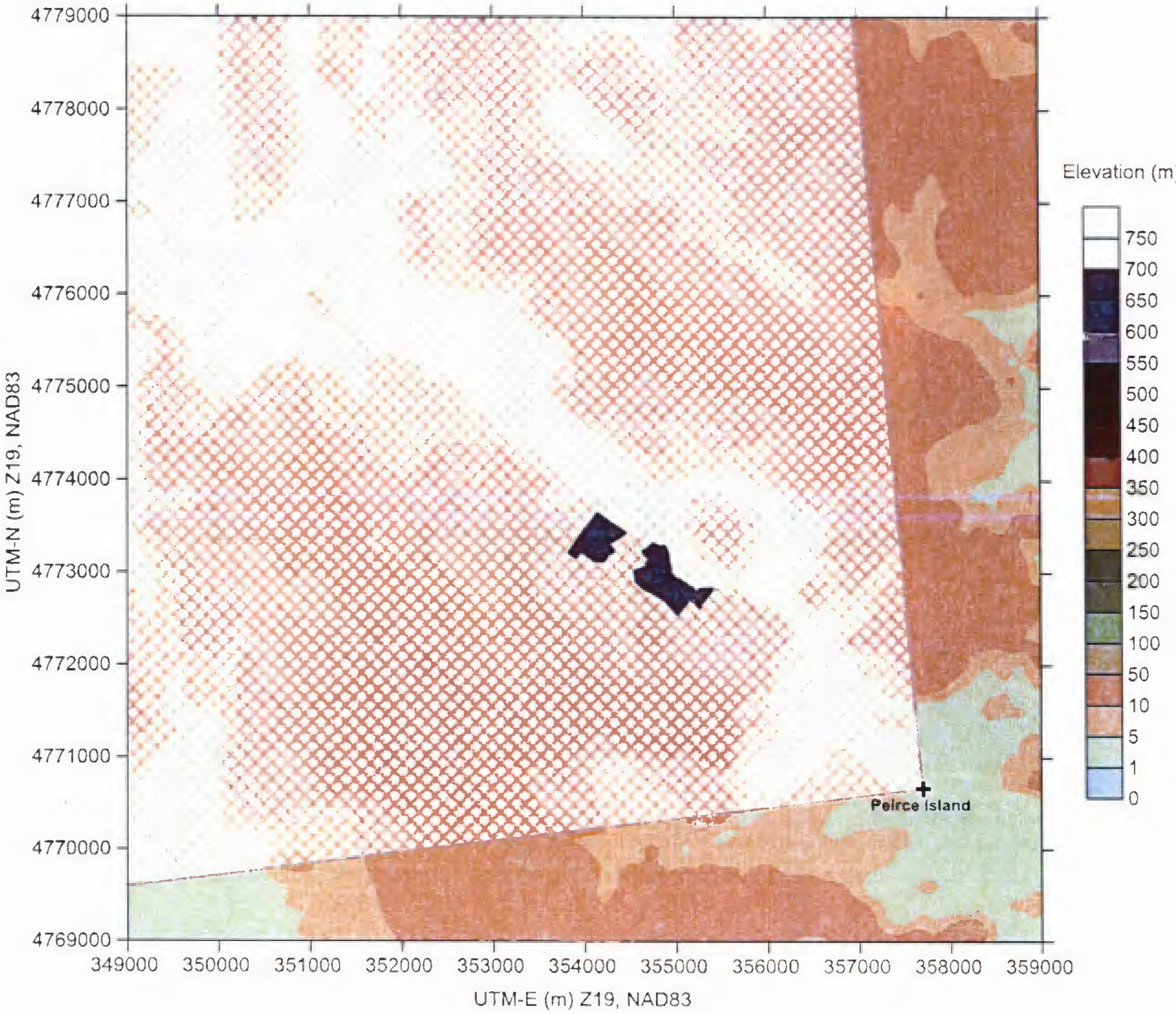

Figure 7. Plot of the 263° – 355° exclusion sector centered on the Peirce Island monitor. Schiller Station and Newington Stations are located within the blue polygon. The exclusion sector is overlaid on the local topography.

Table 2. SO_2 background as a function of season and hour-of-day

Monitored Background for Schiller (2012-2014) (µg/m³)				
Hour	**Winter**	**Spring**	**Summer**	**Fall**
0	8.68	9.16	5.20	6.80
1	8.20	9.59	5.14	6.78
2	10.03	9.16	4.62	7.15
3	10.55	7.85	4.53	7.32
4	10.20	8.28	5.06	7.24
5	9.68	7.85	5.14	8.11
6	11.68	9.24	5.23	8.37
7	11.16	10.20	7.59	8.81
8	10.46	9.33	6.02	8.28
9	10.99	6.15	5.75	8.89
10	10.64	7.67	5.58	6.04
11	11.07	6.71	5.06	6.19
12	9.68	5.84	5.06	5.32
13	9.16	5.32	4.71	5.06
14	8.02	8.28	5.23	4.71
15	8.28	4.62	4.62	4.97
16	7.67	4.97	4.45	4.88
17	7.85	4.88	4.88	5.23
18	8.37	6.36	4.71	6.89
19	9.50	5.75	4.53	6.89
20	9.16	5.41	4.97	7.06
21	8.54	7.50	5.41	7.32
22	7.93	7.59	5.49	7.32
23	8.46	8.81	4.66	7.69

4 Results

4.1 Compliance with the 1-Hour SO_2 NAAQS for Title V

Schiller Station and Newington Stations were modeled for the five years 2010-2014 (using the keyword "CO POLLUTID SO2") along with the selected background sources using the current version of AERMOD (v15181). As discussed earlier, the beta option ADJ_U* in AERMET was used for the air quality modeling demonstration. This option was expressly developed to remedy unrealistically large over-predictions during low wind speed, stable conditions. It is precisely these conditions that are associated with the largest predicted concentrations for Schiller Station. It is expected that this beta option, which has already been approved for use for an industrial source in Region X, will become a recommended default option when the proposed revisions to the *Guideline on Air Quality Models* become final. A justification document to use beta option ADJ_U* in AERMET for Schiller Station was approved by NHDES, EPA Region 1, and the EPA Model Clearinghouse (EPA, 2016a).

In addition, 1-hour SO_2 background values for 2012-2014 were added in AERMOD as a function of season and hour of day. The five-year averaged, 4th high, maximum daily, one-hour SO_2 predicted concentrations at all receptors for Schiller Station at 100%, 75%, and 50% loads are in compliance with the NAAQS value of 75 parts per billion (ppb) (approximately 196.0 $\mu g/m^3$) as shown in Table 3. Note that the contributions from Newington Station are not included in the modeled background contributions listed in Table 3.

4.2 Data Requirements Rule (DRR) Modeling Demonstration

The same procedures described above for the Title V modeling, including using allowable emissions for Schiller and Newington Stations, were also used in the modeling to establish the area attainment designation in the vicinity of Schiller Station with respect to the 1-hour NAAQS for SO_2, except that the DRR modeling was performed using the three most recent calendar years of meteorological data (2012-2014).

The results of the DRR modeling are shown in Table 4. Note that the contributions from Newington Station are not included in the modeled background contributions listed in Table 4.

Table 3 Title V Modeling: 5-year Average 4th-High Maximum Daily 1-hour SO_2 Predicted Concentrations

Pollutant and Averaging Period	Schiller Station Load	Schiller Station Contribution (μg/m³)	Newington Station Contribution (μg/m³)	Modeled Background Contribution (μg/m³)	Monitored Background Contribution (μg/m³)	Total Concentration (μg/m³)	NAAQS (μg/m³)
SO_2 1-hour	100%	129.9	54.9	0.1	6.9	191.8	196.0
	75%	149.1	16.5	0.0	9.0	174.6	
	50%	149.9	3.0	0.0	7.5	160.4	

Table 4 DRR Modeling: 3-year Average 4th-High Maximum Daily 1-hour SO_2 Predicted Concentrations

Pollutant and Averaging Period	Schiller Station Load	Schiller Station Contribution (μg/m³)	Newington Station Contribution (μg/m³)	Modeled Background Contribution (μg/m³)	Monitored Background Contribution (μg/m³)	Total Concentration (μg/m³)	NAAQS (μg/m³)
SO_2 1-hour	100%	128.2	59.7	0.0	8.0	195.9	196.0
	75%	124.6	46.3	0.1	6.0	177.0	
	50%	153.3	0.8	0.0	8.1	162.2	

5 References

NHDES. 2006. "Guidance and Procedure for Performing Air Quality Impact Modeling in New Hampshire" NHDES, Air Resources Division, 29 Hazen Drive, Concord, NH. July, 2006. Accessed June 12, 2016. http://des.nh.gov/organization/commissioner/pip/forms/ard/documents/ard-05-1.pdf.

U.S. EPA. 2004. User's Guide for the AMS/EPA Regulatory Model AERMOD. EPA-454/B-03-001. Sept 2004. U.S. Environmental Protection Agency, Research Triangle Park, NC.

U.S. EPA. 2005. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. Federal Register, November 9, 2005. U.S. Environmental Protection Agency, Research Triangle Park, NC. pp. 68,218-68,261.

U.S. EPA. 2010. Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard. Available at: http://www.epa.gov/ttn/scram/guidance/clarification/ClarificationMemo_AppendixW_Hourly-SO2-NAAQS_FINAL_08-23-2010.pdf. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

U.S. EPA. 2011. Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard. Available at: http://www.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

U.S. EPA, 2014. Guideline on Air Quality Models, Title 40, Part 51, Appendix W.

U.S. EPA, 2015a. *AERMOD Implementation Guide (Revised).* U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. August 3, 2015.

U.S. EPA. 2015b. "Proposed Updates to AERMOD Modeling System." Roger W. Brode, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Air Quality Modeling Group. 11th Modeling Conference, Research Triangle Park, NC. August 12, 2015. Accessed January 25, 2016. http://www.epa.gov/ttn/scram/11thmodconf/presentations/1-5_Proposed_Updates_AERMOD_System.pdf.

U.S. EPA. 2016a: "Model Clearinghouse Review of the Use of the ADJ_U* Beta Option in the AERMET Meteorological Processor (Version 15181) for the Schiller Station Modeling Demonstration." George Bridgers, Office of Air Quality Planning and Standards, Air Quality Modeling Group. Research Triangle Park, NC. April 29, 2016. Accessed June 12, 2016. https://www3.epa.gov/ttn/scram/guidance/mch/new_mch/16-I-01_MCResponse_Region1_Schiller-04292016.pdf

U.S. EPA, 2016b. SO_2 NAAQS Designations Modeling Technical Assistance Document (Draft-Feb 2016). U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Air Quality Assessment Division.